REMARKS

Claims 166-169, 172-174, 177-180, and 189 are pending in the Application

Claims 173-174 are withdrawn from consideration and cancelled without prejudice.

Claims 166-169, 172, 177-180, and 189 are rejected.

Claim 189 is amended herein.

I. RESTRICTION UNDER 35 U.S.C. § 121

The Examiner restricted the claims into two Groups. On April 12, 2006, Applicant responded to the Office Action having a mailing date of March 24, 2006 ("Restriction Requirement"), having a shortened statutory period for response set to expire on March 24, 2006, and elected to continue prosecution of Group I (Claims 166-169, 172-174, 177-180, and 189) without traverse. Claims 173-174 are withdrawn from consideration and have been cancelled herein without prejudice.

II. REJECTIONS UNDER 35 U.S.C. § 103(a) OVER *KIANG*

The Examiner has rejected Claims 166-167, 172 and 189 under 35 U.S.C. § 103(a) as being unpatentable over Kiang et al. "Carbon Nanotubes with Single-Layer Walls." *Carbon*, 33, 7, 903-914 (1995) ("*Kiang*"). Final Office Action, at 2.

The Examiner makes reference to "page 903, the left column and page 905 of *Kiang*, the second column, lines 2-12 and to Figures 2a, 2b and 2c." Final Office Action, at 2. The Examiner contends "[t]hese portions of *Kiang* disclose a substantially two-dimensional membrane of substantially parallel single-wall carbon nanotubes." Final Office Action, at 2-3 Examiner further contends that "[w]ith spacing between the nanotubes, the membrane is nanoporous. Not all of the nanotubes in the figures are substantially parallel; however, many of the nanotubes in this figure are substantially parallel." Final Office Action, at 3. Examiner

further contends that "[i]t would have been obvious to one of ordinary skill in this art at the time the invention was made to have utilized 10^3 or 10^6 nanotubes in *Kiang* so that the membrane in *Kiang* could be used as a large conductor in an electrical environment." *Id.* As Applicant does not concur; it maintains its traversal of these rejections.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not based on applicant's disclosure. *See* M.P.E.P. 706.02(j); *see also In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991).

Each of Claims 166-167, 172 and 189, includes the element of a membrane. Applicant has argued that *Kiang* does not teach a membrane, and the Examiner has refuted this argument "because the same forces that are used to hold together and form applicant's membrane are the same forces that hold together the membrane in *Kiang*." Final Office Action, at 3. Applicant has further argued that *Kiang* does not disclose nanotubes that are in a substantially two-dimensional array. The Examiner has refuted this argument because "[f]irst of all, it is noted that applicant has used the word "substantially." This means that the array is not completely two-dimensional. Also, as seen in Figures 2a, 2b and 2c, the nanotubes are substantially in a two-dimensional array." *Id.*

Applicant respectfully traverses both of Examiner's rebuttal arguments, namely Applicant disagrees with Examiner's position that (a) *Kiang* discloses a membrane because the forces that hold the single-wall carbon nanotubes together are the same as those that hold together the nanotubes in the instant invention, and (b) *Kiang* discloses nanotubes that are

substantially in a two-dimensional array. Van der Waals forces are known to hold single-wall carbon nanotubes together in a variety of arrangements and forms. For example, van der Waals forces can hold together single-wall carbon nanotubes in the form of bundles or ropes. It is thus unreasonable to conclude that just because the forces that hold the nanotubes together are the same, that ***arrangement*** of the nanotubes held together are also the same. The arrangement of nanotubes of *Kiang* is aggregated "bundles" of single-wall carbon nanotubes, which are essentially one-dimensional structural forms. Figures 2a, 2b and 2c of *Kiang* show TEM (Transmission Electron Microscope) images of individual single-wall carbon nanotubes and these one-dimensional bundles, not substantially two-dimensional arrays. As the M.P.E.P., makes clear, it is completely proper for an applicant to use of the term "substantially" in conjunction with another term to describe a particular characteristic of the claimed invention. M.P.E.P. §2173.05(b)(D). Such terminology is then viewed as would be understood by a person of ordinary skill in the art of the application. *Id.*; *see also Andrew Corp. v. Gabriel Electronics*, 847 F.2d 819, 6 U.S.P.Q.2d 2010 (Fed. Cir. 1988). A person of ordinary skill in the art would not recognize the aggregated "bundles" of single-wall carbon nanotubes in *Kiang* as substantially two-dimensional arrays of nanotubes.

In view of this, *Kiang* does not teach, suggest or provide motivation for "a membrane comprising an array of at least 10^3 single-wall carbon nanotubes in a substantially parallel relationship, wherein the membrane is nanoporous and wherein the array is a substantially two-dimensional array," as claimed in Claim 166. Because *Kiang* does not teach, disclose or suggest all the elements of Claim 166, this claim is not *prima facie* obvious.

Regarding Claim 167, this claim is dependent upon Claim 166 and thus includes all the elements of Claim 166. As stated above, *Kiang* does not teach, disclose or suggest all the elements of Claim 166. Furthermore, Claim 167 also requires that the membrane is conductive, and, even if it were assumed for the sake of argument that *Kiang* did teach, disclose or suggest a

membrane. *Kiang* does not teach, disclose or suggest a membrane that is conductive. Thus, Claim 167 is not *prima facie* obvious.

Regarding Claim 172, this claim includes the element of a membrane comprising carbon fibers that are aggregates of a plurality of single-wall carbon nanotubes, including the limitation that the plurality be at least 10^6 single-wall carbon nanotubes and that the membrane is substantially two-dimensional. Claim 172 requires:

> 172. A membrane comprising carbon fibers that are aggregates of a plurality of at least 10^6 single-wall carbon nanotubes, wherein the plurality of single-wall carbon nanotubes are in a generally parallel orientation, and wherein the membrane is substantially two-dimensional.

As stated above, *Kiang* discloses one-dimensional bundles of single-wall carbon nanotubes. *Kiang* does not teach, disclose or suggest a substantially two-dimensional membrane comprising carbon fibers that are aggregates of a plurality of at least 10^6 single-wall carbon nanotubes, wherein the plurality of the single-wall carbon nanotubes are in a generally parallel orientation. Because *Kiang* does not teach, disclose or suggest all the elements of Claim 172, nor provide motivation for one of ordinary skill to modify the reference to include all the elements of Claim 172, this claim is not *prima facie* obvious.

Regarding Claim 189, this claim was dependent upon Claim 173, which is cancelled as a result of the Restriction Requirement. Therefore, Claim 189 has been rewritten in independent form including all of the elements of Claim 173. Claim 189 now requires:

> 189. A membrane comprising: (a) carbon fibers that are aggregates of a plurality of single-wall carbon nanotubes, wherein the plurality of single-wall carbon nanotubes are in generally parallel orientation, wherein the plurality of single-wall carbon nanotubes is at least 10^6 single-wall carbon nanotubes and wherein the membrane is a substantially two-dimensional membrane; and (b) at least one dopant physically entrapped between the single-wall carbon nanotubes of the carbon fibers.

As stated above, *Kiang* discloses one-dimensional bundles of single-wall carbon nanotubes. *Kiang* does not teach, disclose or suggest a substantially two-dimensional membrane comprising carbon fibers that are aggregates of a plurality of at least 10^6 single-wall carbon nanotubes, wherein the plurality of the single-wall carbon nanotubes are in a generally parallel orientation. Furthermore, *Kiang* does not teach, disclose or suggest at least one dopant physically entrapped between the single-wall carbon nanotubes of the carbon fibers. Because *Kiang* does not teach, disclose or suggest all the elements of amended Claim 189, this claim is not *prima facie* obvious.

Therefore, as a result of the foregoing, Applicant respectfully requests that the Examiner withdraw his rejection of Claims 166, 167, 172 and 189 under 35 U.S.C. § 103(a) as being unpatentable over *Kiang*.

III. REJECTIONS UNDER 35 U.S.C. § 103(a) AS BEING OBVIOUS OVER *KIANG* IN VIEW OF *MURPHY* AND IN VIEW OF *IKEDA*

The Examiner has rejected Claims 168-169 and 177-180 under 35 U.S.C. § 103(a) as being unpatentable over *Kiang* in view of both Murphy *et al.*, U.S. Patent 6,448,412 ("*Murphy*") and Ikeda *et al.*, U.S. Patent 5,879,836 ("*Ikeda*"). Final Office Action, at 4.

Examiner contends that "*Kiang* sets forth all of the claimed subject matter except for the photoactive molecule attached to the membrane and for a lithium ion battery having a membrane. Murphy teaches…a fluorescent dye labeled to a fullerene." Final Office Action, at 4. Examiner contends that "[t]o thus include in the single wall carbon nanotubes of *Kiang* the fluorescent dye as shown by *Murphy* would have been obvious to one of ordinary skill in this art at the time the invention was made so that the nanotubes can be traced." *Id.*

Regarding Claims 168 and 169, these claims require:

> 168. A membrane comprising: (a) an array of at least 10^3 single-wall carbon nanotubes in a substantially parallel relationship, wherein the membrane is

nanoporous and wherein the array is a substantially two-dimensional array; and (b) at least one photoactive molecule attached to the membrane.

169. A membrane comprising an array of at least 10^3 single-wall carbon nanotubes in a substantially parallel relationship, wherein (a) the membrane is nanoporous; (b) the array is a substantially two-dimensional array; and (c) at least one of the single-wall carbon nanotubes have ends that are derivatized with a photoactive dye molecule.

With regard to Claims 168 and 169, both of these claims require, *inter alia*, that the membrane comprise (i) an array of at least 10^3 single-wall carbon nanotubes in a substantially parallel relationship, (ii) a membrane that is nanoporous, and (iii) the array is a substantially two-dimensional array. As asserted above, *Kiang* does not teach, disclose, or suggest a membrane of a substantially two-dimensional array of at least 10^3 single-wall carbon nanotubes in a substantially parallel relationship, wherein the membrane is nanoporous.

In contrast, *Murphy* teaches methods for multiply-derivatizing fullerenes having a C_{21-239} fullerene core. The chemistry and properties of single-wall carbon nanotubes are considerably different than the fullerenes disclosed by *Murphy* such that one of ordinary skill in the art would not look to *Murphy* as a reference with which to modify *Kiang*, and if such modification were done, there would be no reasonable expectation of success. The fullerenes of *Murphy* include buckyballs and small fullerenes which have either no aspect ratio, like a soccer ball, or a very short aspect ratio, like a football, and as such cannot be readily aligned. Furthermore, due to their particular shape, the fullerenes of *Murphy* can easily be purified and dispersed. Thus, functionalization of such fullerenes can be done without many of the complications that are present with single-wall carbon nanotubes. Single-wall carbon nanotubes, in contrast, are more difficult to manipulate because of their strong tendency to adhere to each other, particularly in "ropes." Furthermore, the flexibility of single-wall carbon nanotubes can further complicate dispersion because the nanotubes tangle and van der Waals forces hold the tangles strongly together, rendering the nanotubes difficult to physically, as well as, chemically, manipulate.

Thus, the combination of *Kiang* and *Murphy* is anything but obvious. And, therefore, the Examiner's statement "[t]o have incorporated in one carbon material-*Kiang*, that which is utilized in another carbon material-*Murphy*, is a straightforward obvious substitution of no patentable moment" (Final Office Action, at 4-5) is incongruous with the facts. Moreover, even if this substitution could be characterized as straightforward to do, it does not address the fundamental question as to why one of ordinary skill in the art would do the substitution in the first instance.[1]

Applicant notes the teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not in applicant's disclosure. The only way one could arrive at the presently claimed invention would be through the use of hindsight. Hindsight of course is not permissible in § 103 analysis. "One cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention." *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596, 1600 (Fed. Cir. 1988).

Neither *Kiang* nor *Murphy* provides any suggestion or motivation to modify its processes to produce the combination of elements of either Claim 168 or 169. With regard to Claim 168, neither *Kiang* nor *Murphy* provides motivation for a photoactive molecule to a membrane of single-wall carbon nanotubes with the elements provided in Claim 168. Likewise, with regard to Claim 169, neither *Kiang* nor *Murphy* provide motivation for the ends of single-wall carbon nanotubes of a membrane with the elements provided in Claim 169 to be derivatized with a photoactive dye molecule.

Finally, *Kiang* and *Murphy* fail to teach all the claimed limitations of each of Claims 168 and 169. Thus, even, if the teachings of *Kiang* and *Murphy* were combined, the combination

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[1] The Examiner has likewise stated it was a straightforward obvious substitution to combine *Ikeda* with *Kiang* because both are in the same field. Final Office Action, at 5. Thus, the fundamental question as to why *Ikeda* and *Kiang* would be combined is not addressed within the Final Office Action.

would not teach, disclose, or suggest all the claim limitations of either Claim 168 or 169. Furthermore, there is no reasonable expectation of success that, were the processes of *Kiang* actually modified, they would result in the elements claimed in either Claim 168 or 169. Consequently, none of the basic criteria for establishing a *prima facie* case of obviousness have been met in rejecting Claims 168 or 169. Accordingly, Applicant respectfully requests the Examiner withdraw the rejection of Claims 168 and 169 under 35 U.S.C. § 103(a) as being unpatentable over *Kiang* in view of *Murphy*.

Regarding Claims 177-180, Examiner contends "*Ikeda et al.* discloses a lithium ion battery having nanotubes." Final Office Action, at 4. The Examiner further contends "[t]o have utilized the nanotubes in *Kiang* in the lithium battery shown by *Ikeda* would have been obvious so that a great output could have been realized because of the superior performance of the lithium ion battery." *Id.*

Regarding Claims 177 and 179, these claims require:

> 177. A battery comprising a membrane, wherein the membrane comprises an array of at least 10^3 single-wall carbon nanotubes in a substantially parallel relationship, wherein the array is a substantially two-dimensional array.
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> 179. A battery comprising a membrane, wherein the membrane comprises carbon fibers that are aggregates of a plurality of at least 10^6 single-wall carbon nanotubes, wherein the plurality of single-wall carbon nanotubes are in a generally parallel orientation, and wherein the membrane is substantially two-dimensional.

Regarding Claim 177, *Kiang* does not teach, disclose, or suggest a battery comprising a membrane comprising a substantially two-dimensional array of at least 10^3 single-wall carbon nanotubes in a substantially parallel relationship. Likewise, regarding Claim 179, *Kiang* does not teach, disclose, or suggest a battery comprising a substantially two-dimensional membrane comprising carbon fibers that are aggregates of a plurality of at least 10^6 of single-wall carbon nanotubes in a generally parallel orientation.

Ikeda discloses a lithium ion battery comprising "fibril nanotubes." (See *Ikeda*, Col. 3, lines 42-44.) These "fibril nanotubes," also known as "fibrils," have also been referred to as multi-wall carbon nanotubes having many walls. *Ikeda* teaches aggregates comprising fibrils wherein the "carbon fibrils of 3.5 to 75 nm in diameter are intertwined with each other." (See *Ikeda*, Col. 3, lines 61-67.) In contrast to *Ikeda's* teaching of fibrils, Claims 177 and 179 require single-wall carbon nanotubes, which are generally regarded to possess properties and handling characteristics significantly different than those of fibrils.

The distinction between single-wall carbon nanotubes and fibrils is important because fibrils are fundamentally different from single-wall carbon nanotubes. The structural differences between single wall carbon nanotubes and fibrils cause the materials to have very different properties, as well as significant and unpredictable chemical reactivity and performance differences.

Single-wall carbon nanotubes (SWNT) have only a single layer of sp^2-hybridized carbon atoms, generally arranged in a hexagons and pentagons. SWNT are smaller in diameter than fibrils and quite flexible. SWNT also "rope" and are held tightly together by van der Waals forces. In contrast, carbon fibrils are composed of multiple, cylindrical concentric carbon layers, arranged generally in a nested fashion. Fibrils are much thicker and stiffer than single-wall carbon nanotubes and are quite rigid and quite inflexible. Fibrils also do not "rope" together. The structural differences between single-wall carbon nanotubes and fibrils result in numerous differences in physical and chemical properties, such as tensile strength, modulus, flexibility, thermal conductivity, electrical conductivity, chemical reactivity and chemical stability.

The fibrils taught by *Ikeda* also have much larger diameters than those of single-wall carbon nanotubes, which generally range from about 0.7 nm to about 3 nm. (*See, e.g.*, p. 35 of M. Dresselhaus, *et al.*, (Ed) "Carbon Nanotubes, Topics Appl. Phys. 80 29-53 (2001) provided in **Exhibit A** of the Office Action reply filed June 9, 2005.) *Ikeda* teaches that "[w]hen it [the

diameter of the fibril] is less than 3.5 nm, the carbon fibrils may scatter and become difficult to handle." (See *Ikeda*, Col. 5, lines 39-41.) Thus, *Ikeda* ***teaches away*** from nanotubes having diameters less than 3.5 nm, and, therefore, ***teaches away*** from single-wall carbon nanotubes.

Besides having larger diameters, *Ikeda* teaches that the "carbon fibrils of 3.5 to 75 nm in diameter are intertwined with each other." (See *Ikeda*, Col. 3, lines 66-67.) Thus, *Ikeda* again ***teaches away*** from the elements of Claims 177 and 179 that require the single-wall carbon nanotubes to be in arranged in a substantially parallel relationship or generally parallel orientation, respectively.

Ikeda must be considered in its entirety (*i.e.*, as a whole), including those portions identified above that lead away from the claimed invention. M.P.E.P. §2141.02; see also *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 U.S.P.Q. 303 (Fed. Cir. 1983). The Federal Circuit and its predecessor Courts have long held that "[i]t is impermissible within the framework of section 103 to **pick and choose** from any one reference only so much of it as will support a given position to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one skilled in the art." *Bausch & Lomb, Inc. v. Barnes-Hind/Hydrocurve*, 796 F.2d 443, 448, 230 U.S.P.Q. 414, 419 (Fed. Cir. 1986) (quoting *In re Wesslau*, 353 F.2d 238, 241, 147 U.S.P.Q. 391, 393 (C.C.P.A. 1965)).

Regarding Claims 177 and 179, Applicant notes that the teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art and not in applicant's disclosure. In particular, there is no suggestion or motivation in either *Kiang* or *Ikeda*, taken alone or together, to combine the teachings of *Kiang* with the teachings of *Ikeda*, and even if teachings of *Kiang* and *Ikeda* were combined, the combination would not teach or suggest all of the limitations of Claim 177 or 179. Not only is there no suggestion or motivation to make the claimed combination, the teachings of Ikeda ***teach away*** from the combination. The only way one could arrive at the presently claimed invention would be through the use of hindsight, which is not permissible in § 103 analysis.

Thus, Applicant asserts that Claims 177 and 179 are not *prima facie* obvious, and Claim 180, which is dependent upon Claim 179, is also not *prima facie* obvious for the same reasons that Claims 179 is not *prima facie* obvious.

Therefore, as a result of the foregoing, Applicant respectfully requests that the Examiner withdraw his rejection of Claims 168, 169, and 177-180 under 35 U.S.C. § 103(a) as being unpatentable over *Kiang* in view of both *Murphy* and *Ikeda*.

IV. CONCLUSION

As a result of the foregoing, it is asserted by Applicant that the Claims in the Application are now in a condition for allowance, and respectfully requests allowance of such Claims.

Applicant respectfully requests that the Examiner call Applicant's attorney at the below listed number if the Examiner believes that such a discussion would be helpful in resolving any remaining problems.

Respectfully submitted,
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Dated: October 17, 2006

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